## APPENDIX C

## **GEOTECHNICAL**

The Oxbow-Riverside Drive study considers the impacts of constructing a multi-purpose park and wetland within a 170-acre parcel along the Trinity River. The study area is located east of downtown Fort Worth on the West Fork of the Trinity River. The largest portion of the study area lies downstream of Riverside Drive, extending to a point just downstream of Beach Street. The reach includes the old West Fork channel, which formed an oxbow when the channel was realigned.

General Geological Features The Oxbow-Riverside study area lies within the Trinity River alluvium overlying the Fort Worth Limestone and Duck Creek Formation undivided. The alluvium consists of sands, sandy clays, and gravel that were deposited by the river. The underlying primary materials are formations of calcareous clay and limestone that were deposited in a sedimentary geologic environment during the Cretaceous Period.

According to the Soil Survey of Tarrant County, Texas the soil unit in the study area belongs to the Frio-Trinity series. The Frio series consists of well-drained, deep clayey soils that were formed in calcareous, recent alluvium. Typical pedon consists of moderately alkaline, dark grayish brown silty clays that are plastic, firm to very hard, moderately fine, and have a medium blocky structure. The underlying soil is a moderately alkaline, silty clay loam that is plastic, dark brown to brown, very hard, moderately fine, and has a medium subangular blocky structure. The permeability of the Frio soil is moderately slow and the available water capacity is high. Generally, these soils are well suited for use as cropland, pastureland, and are moderately suited for most recreational uses. The main limitation of the Frio soils is the hazard to flooding.

Morphology The majority of the Oxbow is in its natural state in that the channel banks are fairly steep and covered with natural vegetative growth. Flow from the Trinity River has been cut off to the Oxbow and now the only means of water accumulation is from surface runoff. A slight meandering of the channel has allowed the build-up of alluvial soils that were deposited during flood events. Most of the Trinity River channel in the study area has been modified to provide a higher level of flood protection. The channel banks along this reach were constructed from native soils and on 3H:1V slopes. The embankments are grass covered and well maintained. The river is generally non-meandering, which has limited surface erosion and scouring of the channel sides and bottom. Sedimentation build-up within the channel bottom is minimal.

Existing Geological Investigations The U.S. Army Corps of Engineers, Fort Worth District (COE), through its contractor Tetra Tech NUS, Incorporated, performed a geotechnical investigation at various locations within the study area in early May 2002, as described below in "Geotechnical Studies." A geotechnical investigation performed by Mas-Tek Engineering & Associates, Incorporated, for the design and construction of a low water dam that is being built approximately 700 feet downstream of the Beach Street Bridge, was also reviewed. For the purpose of this report, geological features will be delineated using the May 2002 Corps of Engineers field investigation, and the Mas-Tek Engineering report, as well as information from the University of Texas, Bureau of Economic Geology and the Soil Survey of Tarrant County, Texas.

Geotechnical Studies A geotechnical field investigation was performed under contract by Tetra Tech NUS, Incorporated (Houston, Texas), and their drilling subcontractor, Groundwater

Monitoring, Incorporated, in early May 2002, at the locations of the Riverside Drive bridge (subsequently deleted from the project), Beach Street bridge, the proposed upstream and downstream levee bridges, and the proposed parkroad bridge. The purpose of the investigation was to identify subsurface conditions and obtain representative soil and rock samples for laboratory testing. Groundwater Monitoring, Incorporated, used a truck-mounted drill rig, model CME-75, to accomplish drilling for the field investigation. Hollow-stem 6-inch O.D./2.25-inch I.D. continuous flight augers were used to advance the borings, while 2-inch (O.D.) split spoon samplers were used to collect disturbed overburden soil samples, 3-inch (O.D.) thin walled shelby tube samplers were used to collect undisturbed overburden samples, and a 3-inch O.D./2.125-inch I.D. NX core barrel was used to collect rock core samples.

For the purpose of this report, results of the field investigation and laboratory testing programs were used to characterize the foundation conditions for new bridge construction. In addition, the competency of the existing and proposed embankments and levees were evaluated, along with proposed channel construction. It should be noted that where a difference existed between the field visual description of a soil stratum (as depicted on the logs of borings) and the laboratory classification of that material, the laboratory classification was generally used in the site subsurface condition descriptions presented below.

**Subsurface Conditions at the Riverside Drive Bridge** Two COE boreholes, designated 8A4C-1 and 8A4C-2, were drilled adjacent to the Riverside Drive bridge. The locations of these two borings are presented on Plate G-1, located in Appendix B.

Boring 8A4C-1 was drilled on the south side of the Trinity River, approximately 100 feet west of the bridge abutment, and advanced to a total depth of 63 feet. The surveyed ground surface elevation at the location of boring 8A4C-1 was determined to be 505.75 feet above mean sea level (msl) using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-1 consisted of 53 feet of interbedded alluvial deposits, overlying shale and limestone primary. A stiff to very stiff, damp, sandy, silty, brown low plasticity (field visual description) clay was encountered from the surface to a depth of 14 feet, beneath which a three-foot thick layer of medium stiff, moist, brown clayey silt occurs, underlain by a three-foot thick layer of loose, fine-grained, moist, silty sand. A medium stiff, moist to wet (at 22 feet), brown, clayey, slightly plastic (field visual description) silt to silty clay, occurs beneath the sand to a depth of 40 feet, and grades into a brown silty sand in the lower 8 feet of the deposit. This lower sand layer, 13 feet in thickness, grades between coarser and finer grain sizes, with varying amounts of gravel, silt, and clay, and probably constitutes a meandering channel depositional sequence. Very stiff, fossiliferous dark gray clay shale, interbedded with limestone seams, was encountered at a depth of 53 feet, and continued to the total depth of boring advancement (63 feet), at which point hard limestone was encountered, resulting in auger refusal.

Disturbed soil samples, stored in jars, and undisturbed 2-inch diameter shelby tube samples were collected from the overburden and primary (shale) materials encountered within boring 8A4C-1. Undisturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, Atterberg limits, dry unit weight, shear strength (unconsolidated-undrained triaxial test), and consolidation. The silty clay/clayey silt deposited directly above the sand stratum was found to have a dry unit weight of 106.1 pounds per cubic feet, a liquid limit of 36 percent, a plasticity index of 23 percent, a field moisture content of 21.7 percent, and an undrained shear strength of 1,760 pounds per square foot. A sample recovered from the lower sand stratum was determined to have a dry unit weight of 104.6 pounds per cubic foot and a field moisture content of 14.6 percent. A

specimen of the clay shale primary was determined to have a dry unit weight of 106.5 pounds per cubic feet, a field moisture content of 19.9 percent, a liquid limit of 60 percent and a plasticity index of 34 percent.

Boring 8A4C-2 was drilled on the north side of the Trinity River, approximately 120 feet west of the bridge abutment, and advanced to a total depth of 70 feet. The surveyed ground surface elevation at the location of boring 8A4C-2 was determined to be 505.78 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-2 consisted of 57 feet of interbedded alluvial deposits, similar to those encountered in boring 8A4C-1, overlying shale and limestone primary. A medium stiff to very stiff, damp, sandy, silty, light brown to dark brown low plasticity (field visual description) clay was encountered from the surface to a depth of 12 feet. Gravel and bits of asphalt were noted in the clay between approximately 9 feet and 12 feet below ground surface, indicating that the clay may be a fill deposit. Below the clay is a medium stiff to stiff, damp to wet (at 20 feet), brown, iron-stained, clayey, sandy silt, which occurs to a depth of 44 feet. A silty, sandy gravel stratum, measuring 13 feet in thickness, and composed of rounded to subangular grains with a maximum diameter of 1 inch, was encountered below the clavey silt layer, and directly above a clay shale primary, similar to that identified in boring 8A4C-1. Horizontal fractures were noted in core specimens of the shale. The borehole was terminated at a depth of 70 feet without encountering a limestone bed thick enough to cause auger refusal.

The overburden and primary materials encountered within boring 8A4C-2 were very similar to those encountered in boring 8A4C-1, and no samples collected from the second boring were subjected to laboratory testing.

Groundwater was encountered in boring 8A4C-1 during drilling within the clayey silt/silty clay layer at a depth of 29 feet, and a static water level was measured at about 17 feet below ground surface (approximate elevations 477 feet msl and 489 feet msl, respectively). Groundwater was encountered within boring 8A4C-2 during drilling within the clayey silt layer at a depth of 20 feet, and a static water level was recorded at a depth of about 18 feet below ground surface (approximate elevations 486 feet msl and 488 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

Logs of boring for 8A4C-1 and 8A4C-2 are presented after the "Design Assumptions" section at the end of this Appendix.

Subsurface Conditions at the Proposed Upstream Levee Bridge One COE borehole, designated 8A4C-3, was drilled at the location of the proposed upstream levee bridge, as presented on Plate G-1

Boring 8A4C-3 was drilled on the north side of the Trinity River, immediately south of the oxbow inlet, and advanced to a total depth of 60 feet. The surveyed ground surface elevation at the location of boring 8A4C-3 was determined to be 502.45 feet msl using global positioning satellite (GPS) survey equipment. Alluvial clays, silts, sands, and gravel only were encountered within boring 8A4C-3 – primary was not contacted. Medium stiff to stiff, damp, brown, silty high plasticity (laboratory classification) clay extends from the surface to a depth of 13 feet. The clay becomes more sandy and less plastic below 13 feet. A medium stiff, damp to wet (at approximately 22 feet), gray silty low plasticity (laboratory classification) clay with an organic odor is encountered at a depth of 20 feet, and

continues to a depth of approximately 35 feet. Below the silty clay, and extending to the total borehole depth, is a stratum of medium coarse to coarse, loose, subrounded sand, with varying amounts of gravel, silt, and clay. Wood debris was noted within the sand stratum. A layer of loose subrounded gravel, measuring approximately 3 feet in thickness, occurs within the sand at a depth of 55 feet.

Disturbed soil samples, stored in jars, were collected from the alluvial overburden materials encountered within boring 8A4C-3. The disturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. A sample collected from the surficial clay layer was found to have a liquid limit of 53 percent, a plasticity index of 32 percent, and a field moisture content of 20.7 percent. Samples of the clay taken below 13 feet (the more sandy zone) were determined to have liquid limits between 29 and 40 percent, plasticity indices between 13 and 20 percent, and field moisture contents between 17.4 and 30.4 percent. The sand was found to be generally non-plastic, although the deepest sand specimen, collected in a more clayey interval between 58 feet and 60 feet below ground surface, exhibited a liquid limit of 32 percent and a plasticity index of 18 percent. Field moisture contents measured within the sand varied between 5.9 percent (gravelly zone) and 17.2 percent.

Groundwater was encountered in boring 8A4C-3 during drilling within the clayey silt/silty clay layer at a depth of 30 feet, and a static water level was measured at about 22 feet below ground surface (approximate elevations 472 feet msl and 480 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

A boring log for 8A4C-3 is presented after the "Design Assumptions" section at the end of this Appendix.

Subsurface Conditions at the Beach Street Bridge Two COE boreholes, designated 8A4C-4 and 8A4C-5, were drilled adjacent to the Beach Street bridge crossing the oxbow. The locations of these two borings are presented on Plate G-1

Boring 8A4C-4 was drilled immediately west of the bridge on the north side of the oxbow, and advanced to a total depth of 35 feet. The surveyed ground surface elevation at the location of boring 8A4C-4 was determined to be 505.74 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-4 consisted of approximately 8 feet of alluvial overburden materials overlying interbedded shale and limestone primary. Stiff, damp, brown, low plasticity (field visual description) silty clay/clayey silt, with variable amounts of sand and gravel, occurs from the surface to a depth of approximately 8 feet. Beneath these surficial clays and silts is a horizon of light brown, interbedded weathered shale and limestone. The shale has a soft to medium stiff, low plasticity (field visual description) clay consistency; limestone beds are thin. Gray unweathered shale and limestone primary was encountered at a depth of 22.5 feet, and was present to the total boring depth. Horizontal fractures were noted within the shale.

Disturbed overburden soil samples, stored in jars, and 2-inch diameter rock core samples were collected within boring 8A4C-4. No undisturbed samples were tested. However, rock core specimens of the limestone primary were subjected to laboratory testing for dry unit weight, moisture content, and unconfined compressive strength. Dry unit weight of the limestone specimens varied from 125.4 pounds per cubic foot to 147.7 pounds per cubic foot. Moisture contents ranged from 5.2 percent

to 10.3 percent. Unconfined compressive strengths for the limestone core specimens varied from 57.5 tons per square foot, to 136.7 tons per square foot.

Boring 8A4C-5 was drilled immediately east of the bridge on the south side of the oxbow, and advanced to a total depth of 60 feet. The surveyed ground surface elevation at the location of boring 8A4C-2 was determined to be 512.03 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-5 consisted of 10 feet of fill, placed atop 48.5 feet of alluvial sands, silts, clays, and gravels, overlying limestone primary. A surficial fill layer was encountered from the surface to a depth of 10 feet. The fill is a mixture of clayey, sandy, gravelly, silty soil, mixed with construction debris including bricks, concrete, wood, and wires. Beneath the fill is a stratum of loose, coarse, damp, brown silty sand, which extends to a depth of approximately 32 feet. A deposit of soft to stiff, gray, low plasticity (laboratory classification) clay, with sand and silt was encountered below the sand stratum to a depth of 56 feet, at which point a gravel stratum, measuring 2.5 feet in thickness, with cobbles and sand, was contacted. Gray and yellow brown limestone primary was encountered below the gravel layer, and penetrated to a depth of 60 feet below ground surface (i.e., 1.5 feet of total penetration into primary).

Disturbed overburden soil samples, stored in jars, were collected within boring 8A4C-5. No undisturbed samples were collected for testing. The disturbed soil samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. Field moisture contents measured in samples collected within the sand stratum varied from 7.5 percent to 26.2 percent. One sand specimen with a higher clay content was determined to have a liquid limit of 29 percent and a plasticity index of 12 percent, while two other sand specimens were found to be non-plastic. Disturbed samples from the clay horizon were determined to have moisture contents ranging from 22.0 percent to 26.7 percent, liquid limits ranging from 31 percent to 43 percent, and plasticity indices varying from 16 percent to 28 percent.

A static groundwater level was established within boring 8A4C-4 at a depth of 0.94 feet (approximate elevation 505 feet). Groundwater was encountered in boring 8A4C-5 during drilling within the sand stratum at a depth of 30 feet, and a static water level was measured at about 17 feet below ground surface (approximate elevations 482 feet msl and 495 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

Logs of boring for 8A4C-4 and 8A4C-5 are presented after the "Design Assumptions" section at the end of this Appendix.

**Subsurface Conditions at the Proposed Downstream Levee Bridge** One COE borehole, designated 8A4C-6, was drilled at the location of the proposed downstream levee bridge, as presented on Plate G-1.

Boring 8A4C-6 was drilled on the north side of the Trinity River, approximately 340 feet east of the Beach Street bridge, and advanced to a total depth of 60 feet. The surveyed ground surface elevation at the location of boring 8A4C-6 was determined to be 526.95 feet msl using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-6 consisted of four feet of fill, placed atop 55.5 feet of alluvial clay and gravel, overlying limestone and shale primary. The fill was described as silty clay with sand and gravel, containing concrete. Below the fill layer, a medium stiff to very stiff, damp to wet (at 30 feet), brown, silty, sandy clay horizon was encountered to a depth

of 58 feet below ground surface. The clay was determined, by laboratory testing, to be high plasticity above a depth of approximately 26 feet below ground surface, and low plasticity below that point. A thin stratum of saturated clayey gravel with sand, with a total thickness of 1.5 feet, was penetrated below the clay horizon. Interbedded gray limestone and shale was contacted beneath the gravel interval.

Disturbed soil samples, stored in jars, and undisturbed 2-inch diameter shelby tube samples were collected from the overburden materials encountered within boring 8A4C-6. Disturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. Undisturbed samples were tested for determination of dry unit weight and shear strength (unconsolidated-undrained triaxial test), as well. As previously noted, clay specimens collected above an approximated depth of 26 feet below ground surface, were determined to be highly plastic, with liquid limits ranging from 55 percent to 62 percent and plasticity indices varying from 35 percent to 45 percent; moisture contents for these specimens ranged from 12.8 percent to 20.5 percent. Clay specimens collected below 26 feet were found to have liquid limits between 26 percent and 33 percent, plasticity indices between 10 percent and 21 percent, and moisture contents ranging from 20.4 percent to 23.4 percent. Furthermore, these (lower) clays were determined to have dry unit weights between 100.8 pounds per cubic foot and 108.9 pounds per cubic foot, and undrained shear strengths between 291 pounds per square foot and 3,560 pounds per square foot. A disturbed sample collected from the basal clayey gravel layer was also tested, and found to have a liquid limit of 26 percent, a plasticity index of 14 percent and a moisture content of 8.1 percent.

Groundwater was encountered in boring 8A4C-6 during drilling within the clayey silt/silty clay layer at a depth of 30 feet, and a static water level was measured at about 25 feet below ground surface (approximate elevations 497 feet msl and 502 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

A boring log for 8A4C-6 is presented after the "Design Assumptions" section at the end of this Appendix.

**Subsurface Conditions at the Parkroad Bridge** One COE borehole, designated 8A4C-7, was drilled at the location of the proposed parkroad bridge, as presented on Plate G-1.

Boring 8A4C-7 was drilled on the south side of the oxbow, approximately 600 feet upstream of the confluence with the Trinity River, and advanced to a total depth of 52 feet. The surveyed ground surface elevation at the location of boring 8A4C-7 was determined to be 506.08 feet above mean sea level (msl) using global positioning satellite (GPS) survey equipment. Soils encountered within boring 8A4C-7 consisted of 3 feet of fill, placed atop 49 feet of alluvial clay, sand, and gravel. The fill was described as clay and silt mixed with wood and organic debris, as well as metal and plastic. Below the fill layer is a medium stiff, damp to wet (at 27 feet), gray to brown, clay horizon containing plant roots. The clay was determined, by laboratory testing, to be high plasticity above a depth of approximately 35 feet below ground surface, and low plasticity below that point, to a depth of approximately 40 feet below ground surface (base of the clay horizon). Caliche was noted filling fractures within the clay. A loose, silty, clayey, gravelly, gray, saturated sand stratum was encountered below the clay interval, and continued to the total boring depth. The sand became more gravelly below an approximate depth of 47 feet.

Disturbed soil samples, stored in jars, and undisturbed 2-inch diameter shelby tube samples were collected from the overburden materials encountered within boring 8A4C-7. Disturbed samples were subjected to laboratory testing for identification, moisture content, grain size distribution, and Atterberg limits. Undisturbed samples were tested for determination of dry unit weight and shear strength (unconsolidated-undrained triaxial test), as well. As previously noted, clay specimens collected above an approximated depth of 35 feet below ground surface, were determined to be highly plastic, with liquid limits ranging from 50 percent to 56 percent and plasticity indices varying from 33 percent to 34 percent; moisture contents for these specimens ranged (narrowly) between 21.2 percent to 21.4 percent. A clay specimen collected below 35 feet was found to have a liquid limit of 29 percent, a plasticity index of 12 percent, and a moisture content of 23.1 percent. Dry unit weight and undrained shear strength for this lower clay were determined to be 103.4 pounds per cubic foot and 204.0 pounds per square foot, respectively. A specimen of the clayey sand with silt was determined to have a liquid limit of 20 percent, a plasticity index of 7 percent, a moisture content of 21.4 percent, and a dry unit weight of 107.2 pounds per cubic foot.

Groundwater was encountered in boring 8A4C-7 during drilling within the clayey silt/silty clay layer at a depth of 27 feet, and a static water level was measured at about 21 feet below ground surface (approximate elevations 479 feet msl and 485 feet msl, respectively). It should be noted, however, that groundwater conditions are relative to the time of drilling, annual precipitation, river elevation, and drainage conditions at the site.

A boring log for 8A4C-7 is presented after the "Design Assumptions" section at the end of this appendix.

Subsurface Conditions at the Low Water Dam (By Others) Mas-Tek Engineering & Associates performed a subsurface investigation at the low water dam site. Two boreholes were drilled at the dam site, one on each side of the Trinity River. The boring drilled on the north side of the river was advanced to a depth of 50 feet and the boring drilled on the south side was advanced to a total depth of 40 feet. Undisturbed cohesive soil samples were collected using seamless tube samplers and standard penetration testing was performed within the non-cohesive materials encountered in each test hole. Representative soil samples were subjected to laboratory testing for identification, moisture content, grain size distribution, Atterberg limits, and dry unit weight. Undisturbed samples were subjected to shear strength and consolidation testing as well.

Soils encountered in the boring drilled on the north side of the river consist of an initial 6-foot layer of very stiff to hard, dark brown clay. Underlying the clay is a 3-foot layer of tan to light brown sandy gravel and a deeper deposit of dark brown to brown clay. The clay transitions from hard to soft with increasing depth and is present to depths of 9 to 43 feet. The last soil feature is a gray, soft, and very wet sand that was present to the total depth investigated, 50 feet.

Subsurface conditions encountered on the south side of the river consist of a surface layer of hard, dark brown gravelly clay to a depth of 3 feet. Beneath the clay is a brown, very stiff to hard clay deposit that extends to an approximate depth of 20 feet. From depths of 20 to 30 feet, the clay becomes slightly sandy and soft, and below 30 feet, the clay becomes very moist to wet. The final soil feature encountered is a tan to light brown sandy clay/clayey sand. This material was penetrated at a depth of 37 feet and is present to the total depth investigated, 40 feet.

Groundwater seepage was noted at the time of drilling at depths of 27 and 28 feet on the north and south sides of the river, respectively. Static levels measured just prior to backfilling the boreholes were 24 feet on the north side and 22 feet on the south side of the river.

**Design Assumptions** The following foundation, pavement, and embankment design assumptions are provided for the development of project alternatives. The assumptions are based on the aforementioned geotechnical studies and engineering judgment.

New Bridge Structures. The proposed bridge structures should be supported on reinforced concrete straight-shaft drilled piers. Based on subsurface information generated from the COE and Mas-Tek field investigations and laboratory testing data, the piers for the Beach Street bridge, parkroad bridge, and downstream levee bridge should be founded 60 feet below ground surface. Piers for the upstream levee bridges should be founded 70 feet below ground surface. Tentatively, an allowable end bearing capacity of 30,000 psf (net) should not be exceeded when sizing the pier shafts. The piers can be sized for both end bearing and skin friction if additional load-carrying capacity is required. For this phase of design, an allowable side shear value of 650 psf can be used over the effective embedment length of the pier. The effective length (L<sub>eff</sub>) starts 10 feet below ground surface and extends to within one shaft diameter of the final bearing depth. All pier shafts should be a minimum of 18 inches in diameter and reinforced with a minimum of 1 percent reinforcing steel. The load used to size the piers should consist of full dead load plus that portion of the live load that acts more or less continuously, usually 50 percent.

Small Support-type Structures. Small support-type structures can be supported on reinforced concrete slabs-on-grade with turned-down edge beams. The turned-down edge beam should extend a minimum of 12 inches below outside finished grade and can be sized for a safe bearing pressure of 2,000 psf (net). Interior beams should be spaced on (maximum) 15-foot centers. Subgrade preparation should consist of providing a minimum of 36 inches of compacted nonexpansive fill below the soil-supported slab.

Embankment Construction. The roadways leading to the bridge structures and the proposed levees should be constructed using compacted satisfactory fill materials. The fill can be obtained from on-site excavations or from approved borrow areas. Satisfactory fill includes materials classified in ASTM D 2487 as GW, GM, GC, GP, SW, SP, SM, SC, CL and CH and shall be free of trash, debris, roots, or other organic matter, or stones larger than 3 inches in any dimension. If a CH material is utilized, it shall be stabilized to a maximum liquid limit of 55 percent and a maximum plasticity index of 20 percent. To prepare the subgrade for placement of fill materials, a minimum of 6 inches of existing materials should be removed and replaced with satisfactory backfill material. Placement of satisfactory fill should be in horizontal layers not exceeding 8 inches in loose thickness. Embankments should be constructed such that a 3H to 1V slope is not exceeded when slope protection (riprap) is not provided. Where concrete slope protection is employed, a maximum slope of 1-1/2H to 1V slope should not be exceeded.

Below-Grade Structures and Dewatering. The following information is provided for the design of all below-grade structures, if applicable. All structures should be designed for at-rest conditions using a lateral earth pressure coefficient ( $k_o$ ) equal to 0.7. In addition, an allowable bearing capacity of 1,500 psf and a cohesion value (c) of 100 psf should be used. All backfill should be nonexpansive material and can be assumed to have a moist unit weight of 125 pcf.

Seasonal groundwater fluctuations within the overburden materials may cause problems with deep excavations. The presence of groundwater should be controlled to prevent sloughing of excavation slopes and walls, and to eliminate interference with the orderly progress of construction. To this end, control measures should be taken in the form of French drains, sumps, ditches or trenches to alleviate the construction area of groundwater and maintain the integrity of the in situ materials.

**Pavement Structures.** The pavement designs presented below are based on criteria contained in TM 5-822-5/AFM 88-7, Chapter 1, TM 5-822-2/AFM 88-7, Chapter 5, and the geotechnical studies presented in this report. The pavement sections can be used for new park road construction and approaches to the new vehicular bridges. The designs consider CBR values of 5 percent for the raw subgrade when compacted to 90 percent of laboratory maximum density, and 20 percent for the Subbase Course when compacted to 95 percent.

Park Roads (Flexible). Use a design index of 2 for Category II traffic and a

Class E street.

1-1/2" Hot-Mix Surface Course

6" Aggregate Base Course compacted to at least 100 percent of maximum laboratory density (ASTM D 1557)

6" Subbase Course compacted to at least 95 percent of maximum laboratory density (ASTM D 1557)

6" Raw Subgrade compacted to at least 90 percent of maximum laboratory density (ASTM D 1557)

Bridge Approaches (Flexible). Use a design index of 5 for Category IVA traffic and a Class D street.

2-1/2" Hot-Mix Surface Course

8" Aggregate Base Course compacted to at least 100 percent of maximum laboratory density (ASTM D 1557)

8" Subbase Course compacted to at least 95 percent of

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maximum laboratory density (ASTM D 1557)

6" Raw Subgrade compacted to at least 90 percent of maximum laboratory density (ASTM D 1557)

Bridge Approaches (Rigid). Use a design index of 5 for Category IVA traffic and a Class D street, a modulus of subgrade reaction of 100 pci, and a concrete flexural strength of 650 psi at 28 days.

- 6" Portland Cement Concrete reinforced with No. 4 bars spaced 16 inches o.c.e.w.
- 6" Aggregate Base Course compacted to at least 95 percent of maximum laboratory density (ASTM D 1557)
- 6" Raw Subgrade compacted to at least 90 percent of maximum laboratory density (ASTM D 1557)

Conclusion The area and site-specific geological and soil conditions have been examined through a map and literature review, and through analysis of data generated through field investigation and laboratory testing programs conducted at the locations of each of the currently identified bridge structures to be included in the project. The results of the field investigation and laboratory testing programs were used to characterize the foundation conditions for new bridge construction. Further, the competency of the existing and proposed embankments and levees were evaluated, along with proposed channel construction. Geotechnical design recommendations have been provided for these features. Additional geotechnical studies may be necessary, depending on the project alternatives identified, or if new design features are added.

LOGS OF BORING

Γ					BOREHOLE	NUMBER	R: 8A4	C-1	Page 1 of 5	
١				1	LATITUDE: 32° 45'	0.515" N				
)				!	LONGITUDE: 97° 1	8' 13.568" W	E	LEVATION/DAT	TUM: 505.751' M.S.L.	
r		PROJEC	T INFORMATION		DRILLING INFORMATION					
	PROJECT: F JOB NUMBE LOGGED B' PROJECT M DATE DRILL	Riverside Ox ER: N7551.0 Y: K. Bell MANAGER: N	bow 42D M. Meenan		DRILLING COMP DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING METI TOTAL DEPTH: 6	lerson 75 ILLING: Hollo HOD: 5' x 2" \$	w Stem A	uger/Rock Corin		
	NOTES:				29.00°  ☐ Initial Water Level 05-09-02					
١					16.76' ▼	Static Water	er Level	05-10-02		
	DEPTH (Feet)	SOIL SYMBOLS	USCS: §	SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
	□0		Surface-wet, grass covere	ed, topsoil.						
	-	CI			actic brittle ctiff	RO-8A4C1- SO-0002				
	- CL Sandy, Silty Clay-dark brown, damp, non-p			isuc, onde, sui.		60/60				
	5									
						RO-8A4C1- SO-0507				
	-	CL	Silty Clay-brown, damp, r		iff, brittle, caliche in		60/60			
	10					RO-8A4C1-				
	-					SO-1012	60/60			
		·								
	L-15						_			
J	SITE MANAGER: CHECKED BY: 1							RIVERS	IDE OXBOW	
)	DRAWN BY: J.				TETRA TECH				ORTH, TEXAS	
	DATE: 05-16-		SCALE: N/A		Houston, Texas		-	COU. 5	ODING TOO	
	CAD DWG. NO.:		PROJ. NO.: N7551.042D				1	SOIL B	BORING LOG	

## Page 2 of 5 **BOREHOLE NUMBER: 8A4C-1** LATITUDE: 32° 45' 0.515" N ELEVATION/DATUM: 505.751' M.S.L. LONGITUDE: 97° 18' 13.568" W PROJECT INFORMATION DRILLING INFORMATION DRILLING COMPANY: Groundwater Monitoring Inc. PROJECT: Riverside Oxbow DRILLER: R. Anderson JOB NUMBER: N7551.042D LOGGED BY: K. Bell RIG TYPE: CME-75 PROJECT MANAGER: M. Meenan METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube **DATE DRILLED: 05-09-02** TOTAL DEPTH: 63' NOTES: Initial Water Level 05-09-02 29.00' 🗸 Static Water Level 05-10-02 16.76' 🔻 ADVANCE/ WELL DESCRIPTION SAMPLE **BORING** DEPTH (Feet) SOIL USCS: SOIL DESCRIPTION RECOVER SYMBOLS NUMBER COMPLETION (Inches) Clayey Silt-brown, damp, medium stiff, slightly plastic. RO-8A4C1-SO-1517 60/36 SM Silty Sand-brown, moist, loose, fine grains. - -20 RO-8A4C1-SO-2022 60/48 - -25 RO-8A4C1-SO-2527 Clayey Silt-brown, moist at 20', wet at 22', saturated at 29', medium stiff, slightly plastic, soft at 22', shell fragments. ML 60/48 又 SITE MANAGER: M. MEENAN RIVERSIDE OXBOW CHECKED BY: K. BELL TETRA TECH NUS, INC. FORT WORTH, TEXAS DRAWN BY: J. FLESCH Houston, Texas DATE: 05-16-02 SCALE: N/A SOIL BORING LOG PROJ. NO.: N7551.042D CAD DWG. NO.: 8A4C-1

			BOREHOLE	NUMBER	R: 8A40	C-1	Page 3 of 5	
			LATITUDE: 32° 45'	0.515" N				
			LONGITUDE: 97° 1	8' 13.568" W	El	LEVATION/DAT	UM: 505.751' M.S.L.	
	PROJEC	T INFORMATION	DRILLING INFORMATION					
PROJECT N DATE DRILL	ER: N7551.0	42D M. Meenan	DRILLING COMP DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET TOTAL DEPTH: (	lerson 75 ILLING: Hollov HOD: 5' x 2" S	v Stem Au	iger/Rock Coring	lube	
NOTES:			29.00' ☑ Initial Water Level 05-09-02  16.76' ▼ Static Water Level 05-10-02					
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIP	TION	SAMPLE	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
-30				RO-8A4C1- SO-3032				
				RO-8A4C1- SO-3435	60/36			
-	ML	Sandy, Clayey Silt-grey, soft, very plastic, \$ coarsens with depth and is located in		RO-8A4C1- ST-3537	60/36			
-40				RO-8A4C1- SO-3940				
45				RO-8A4C1- SO-4045	60/24			
SITE MANAGER: CHECKED BY: DRAWN BY: J.	K. BELL		TETRA TECH		T		DE OXBOW ORTH, TEXAS	
DATE: 05-16-		SCALE: N/A	Houston, Texas			SOIL B	ORING LOG	

**BOREHOLE NUMBER: 8A4C-1** Page 4 of 5 LATITUDE: 32° 45' 0.515" N ELEVATION/DATUM: 505.751' M.S.L. LONGITUDE: 97° 18' 13.568" W PROJECT INFORMATION DRILLING INFORMATION DRILLING COMPANY: Groundwater Monitoring Inc. PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D DRILLER: R. Anderson LOGGED BY: K. Bell RIG TYPE: CME-75 PROJECT MANAGER: M. Meenan METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube DATE DRILLED: 05-09-02 TOTAL DEPTH: 63' NOTES: Initial Water Level 05-09-02 29.00' 🔽 16.76' 💌 Static Water Level 05-10-02 ADVANCE/ WELL DESCRIPTION SAMPLE **BORING** DEPTH (Feet) SOIL USCS: SOIL DESCRIPTION RECOVER SYMBOLS NUMBER COMPLETION (Inches) -45 RO-8A4C1-ST-4547 Silty Sand-brown and tan, variable color in coarse sand. Sand ranges from fine to small gravel in several sequences (point bar progression), thin layers of silt and clay in SP 60/54 -50 RO-8A4C1-ST-5052 60/54 -55 RO-8A4C1-ST-5557 60/54 Shale-dark grey, very stiff, brittle, laminations, fossils. Thin layers of limestone from 61-63'. SHALE SITE MANAGER: M. MEENAN RIVERSIDE OXBOW CHECKED BY: K. BELL TETRA TECH NUS, INC. FORT WORTH, TEXAS DRAWN BY: J. FLESCH Houston, Texas DATE: 05-16-02 SCALE: N/A SOIL BORING LOG PROJ. NO.: N7551.042D

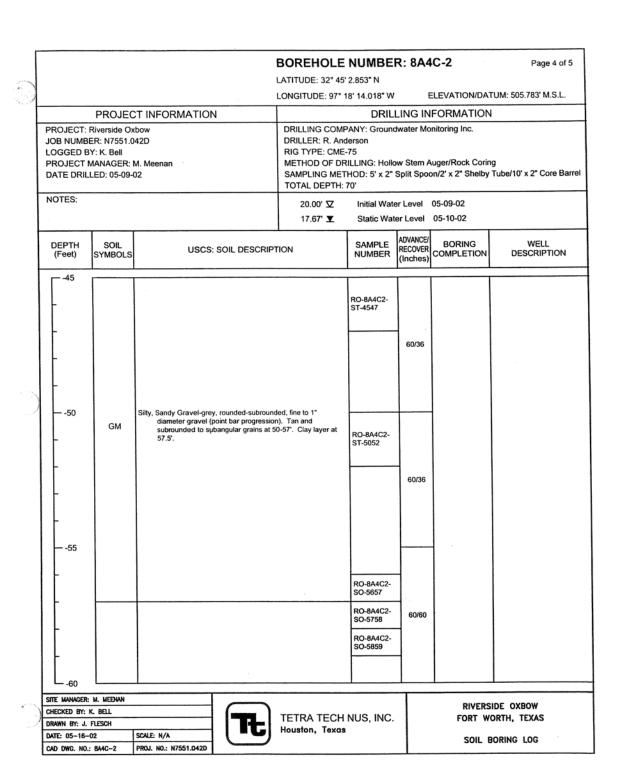
CAD DWG. NO.: 8A4C-1

				BOREHOLE		R: 8A4	IC-1	Page 5 of 5
				LATITUDE: 32° 45'	0.515" N			
				LONGITUDE: 97°	18' 13.568" W		ELEVATION/DA	TUM: 505.751' M.S.L.
	PROJEC	CT INFORMATION	1		DRILI	ING IN	FORMATION	
PROJECT: I JOB NUMBI LOGGED B PROJECT N DATE DRIL	ER: N7551.0 3Y: K. Bell MANAGER:	042D M. Meenan		DRILLING COME DRILLER: R. And RIG TYPE: CME METHOD OF DE SAMPLING MET TOTAL DEPTH:	derson -75 RILLING: Hollo 'HOD: 5' x 2" :	w Stem A	Auger/Rock Corin	ng Tube
NOTES:				29.00' ℧	Initial Wate	er Level	05-09-02	
				16.76' ▼	Static Water	er Level	05-10-02	
DEPTH (Feet)	SOIL SYMBOLS	USCS:	SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
F -60					RO-8A4C1- SO-6061			
					RO-8A4C1- SO-6162	36/36		
						]		
-	LS	Bottom of hole, refusal, Total Depth=63'	limestone.				<u> </u>	
}								
65								
-								
-								
<b>†</b>								
-70								
}								
-								
-								
-								
SITE MANAGER:	: M. MEENAN					Т	DIVERS	SIDE OXBOW
CHECKED BY:			(	TETRA TECH	NUS, INC.			ORTH, TEXAS
DRAWN BY: J.		SCALE: N/A		Houston, Texas				
DATE: 05-16-	-02	SCALE: N/A				1	SOIL	BORING LOG

			BOREHOLE	NUMBER	R: 8A40	C-2	Page 1 of 5	
			LATITUDE: 32° 45'	2.853" N				
}			LONGITUDE: 97° 1	8' 14.018" W	El	EVATION/DAT	'UM: 505.783' M.S.L.	
	PROJEC	CT INFORMATION	DRILLING INFORMATION					
PROJECT: F JOB NUMBE LOGGED B' PROJECT M DATE DRILL	ER: N7551.0 Y: K. Bell MANAGER: I	42D M. Meenan	DRILLING COMP DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET TOTAL DEPTH:	erson 75 ILLING: Hollov HOD: 5' x 2" S	w Stem Au	ger/Rock Corin	g Tube/10' x 2" Core Barrel	
NOTES:			20.00' ☑	Initial Water	r Level 0	5-09-02		
			17.67' ▼	Static Wate	r Level (	05-10-02		
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIP	PTION		ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
_0		Surface-wet, gravel, dirt road bed.						
-	CL Sandy, Silty Clay-brown, non-plastic, stiff, da			RO-8A4C2- SO-0002				
5					60/54			
	CL	Silty Clay-brown, non-plastic, stiff to mediu brown from 6-7", soft, loose, shell fra	um stiff, brittle. Light agments, little caliche.	RO-8A4C2- SO-0507	60/60			
10								
-	CL	Gravelly Clay-dark brown, very stiff, iron s damp, shell fragments, small aspha	staining, non-plastic, alt pieces.	RO-8A4C2- SO-1012				
	Clayey Silt-grades from tan to brown at 15 ML stiff and damp to stiff, brittle and we		5', grades from medium et at 15', iron staining.		60/42	,		
L-15								
SITE MANAGER:							SIDE OXBOW	
DRAWN BY: J.			TETRA TECH		1	FORT W	ORTH, TEXAS	
DATE: 05-16-		SCALE: N/A	Houston, Texas	1	SOIL BORING LOG			

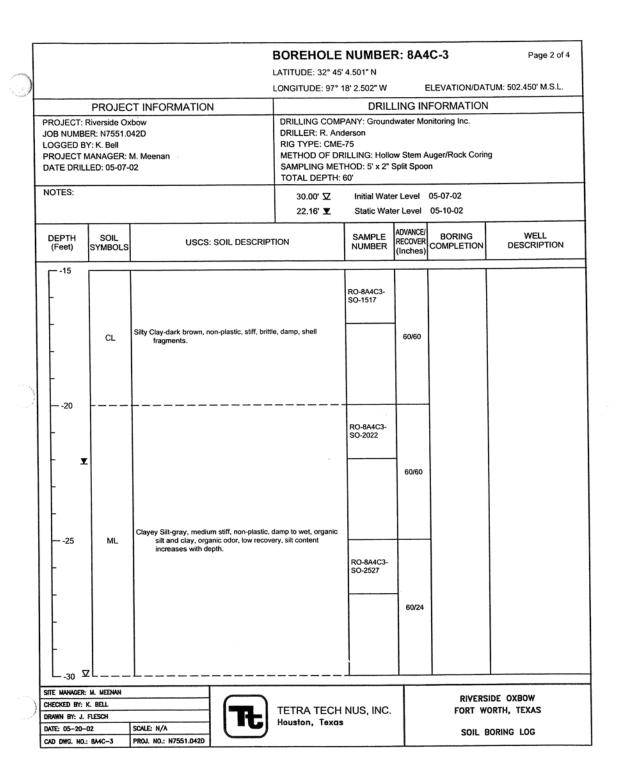
**BOREHOLE NUMBER: 8A4C-2** Page 2 of 5 LATITUDE: 32° 45' 2.853" N LONGITUDE: 97° 18' 14.018" W ELEVATION/DATUM: 505.783' M.S.L. DRILLING INFORMATION PROJECT INFORMATION PROJECT: Riverside Oxbow DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson JOB NUMBER: N7551.042D RIG TYPE: CME-75 LOGGED BY: K. Bell METHOD OF DRILLING: Hollow Stem Auger/Rock Coring PROJECT MANAGER: M. Meenan SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube/10' x 2" Core Barrel **DATE DRILLED: 05-09-02** TOTAL DEPTH: 70' NOTES: Initial Water Level 05-09-02 20.00' 🔽 17.67' ▼ Static Water Level 05-10-02 ADVANCE/ SAMPLE NUMBER WELL DESCRIPTION DEPTH SOIL BORING USCS: SOIL DESCRIPTION RECOVER COMPLETION (Feet) SYMBOLS (Inches) RO-8A4C2-SO-1517 Clayey Silt-grades from tan to brown at 15', grades from medium stiff and damp to stiff, brittle and wet at 15', iron staining. ML 60/60 ¥ -<sub>-20</sub> 又 RO-8A4C2-SO-2022 60/48 Clayey, Sandy Silt-grey, plastic, saturated at 20', sandy in brown layers, silty in layers. MI RO-8A4C2-SO-2426 - -25 60/42 RO-8A4C2-SO-2931 -30 SITE MANAGER: M. MEENAN RIVERSIDE OXBOW CHECKED BY: K. BELL TETRA TECH NUS, INC. FORT WORTH, TEXAS DRAWN BY: J. FLESCH Houston, Texas SCALE: N/A DATE: 05-16-02 SOIL BORING LOG CAD DWG. NO.: BA4C-2 PROJ. NO.: N7551.042D

				BOREHOLE	NUMBE	R: 8A4	IC-2	Page 3 of 5
				LATITUDE: 32° 45'		0/14		1 490 0 010
				LONGITUDE: 97° 1		F	ELEVATION/DAT	TUM: 505.783' M.S.L.
	DDO IEC	T INFORMATION	DRILLING INFORMATION					
DBO IECT:	Riverside Ox		N	DRILLING COMPANY: Groundwater Monitoring Inc.				
JOB NUMB LOGGED B PROJECT	ER: N7551.0 3Y: K. Bell	M. Meenan	,	DRILLER: R. And RIG TYPE: CME- METHOD OF DR	ig Tube/10' x 2" Core Barrel			
NOTES:				20.00' ☑ Initial Water Level 05-09-02 17.67' ▼ Static Water Level 05-10-02				
DEPTH (Feet)	SOIL SYMBOLS	uscs	: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
┌-30								
-	ML	Clayey, Sandy Silt-grey layers, silty in lay		t 20', sandy in brown				
						60/48		
35								
-					RO-8A4C2- ST-3537			
						60/42		
-40						-	4	
					RO-8A4C2- ST-4042			
						60/42		
45								
SITE MANAGER	N MEENIN							
CHECKED BY:								IDE OXBOW
DRAWN BY: J.			77-	TETRA TECH	NUS, INC.		FORT W	ORTH, TEXAS
DATE: 05-16-		SCALE: N/A		Houston, Texas			SOIL F	BORING LOG
CAD DWG NO		PROL NO: N7551 0420				1	SOIL E	BORING LOG



	Page 5 of 5
PROJECT INFORMATION  PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-09-02  NOTES:  DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube/10' x TOTAL DEPTH: 70'  NOTES:  20.00' ▼ Initial Water Level 05-09-02  17.67' ▼ Static Water Level 05-10-02  DEPTH (Feet) SYMBOLS  USCS: SOIL DESCRIPTION  DRILLING INFORMATION DRILLING INFORMATIO	7001 NA C I
PROJECT: Riverside Oxbow JOB NUMBER: N7551,042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-09-02  NOTES:  DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube/10' x TOTAL DEPTH: 70'  NOTES:  20.00'  Initial Water Level 05-09-02  17.67'  Static Water Level 05-10-02  DEPTH (Feet) SOIL SYMBOLS  USCS: SOIL DESCRIPTION  SAMPLE RUMBER  ADVANCE/ RECOVER (Inches) BORING COMPLETION DESCRIPTION  DES	783 M.S.L.
JOB NUMBER: N7551.042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-09-02  NOTES:  DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube/10' x TOTAL DEPTH: 70'  NOTES:  20.00' ☑ Initial Water Level 05-09-02 17.67' ▼ Static Water Level 05-10-02  DEPTH (Feet) SOIL SYMBOLS  USCS: SOIL DESCRIPTION  SAMPLE NUMBER  ADVANCE/ RECOVER (Inches)  BORING COMPLETION DESCRIPTION  DESCRIP	
DEPTH (Feet) SYMBOLS USCS: SOIL DESCRIPTION SAMPLE NUMBER RECOVER (Inches) COMPLETION DESCRIPTION DES	2" Core Barrel
DEPTH (Feet) SYMBOLS USCS: SOIL DESCRIPTION SAMPLE NUMBER COMPLETION DESCRIPTION DESCRIPTI	
DEPTH SOIL SYMBOLS USCS: SOIL DESCRIPTION SAMPLE NUMBER (Inches) COMPLETION DESCRIPTION	
-60	WELL CRIPTION
Shale-dark grey, stiff, very stiff medium soft rock, laminations, some limestone, fossils, core from 60-70', recovery 4'6" of rock, horizontal fracturing, strong bedding features. Could be classified as mudstone.  RO-8A4C2-RK-6070  Bottom of hole.  Total Depth=70'	
75	
SITE MANAGER: M. MEENAN CHECKED BY: K. BELL DRAWN BY: J. FLESCH DATE: 05-16-02 SCALE: N/A  RIVERSIDE OXBO FORT WORTH, TE Houston, Texas  SOIL BORING LO	XAS

			BOREHOLE	NUMBER	R: 8A40	C-3	Page 1 of 4
			LATITUDE: 32° 45'				
			LONGITUDE: 97° 1	18' 2.502" W	El	EVATION/DAT	UM: 502.450' M.S.L.
	PROJEC	CT INFORMATION	DRILLING INFORMATION				
LOGGED B PROJECT I	ER: N7551.0	M. Meenan	DRILLING COMP DRILLER: R. And RIG TYPE: CME METHOD OF DR SAMPLING MET TOTAL DEPTH:	derson -75 RILLING: Hollo 'HOD: 5' x 2" S	w Stem Au	ger/Rock Coring	
NOTES:			30.00' ☑ Initial Water Level 05-07-02				
			22.16' ▼ Static Water Level 05-10-02				
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
_0		Surface-grass, damp, topsoil.					
-	CL	Topsoil-silty clay, brown, iron staining, roots medium stiff.	, non-plastic, damp,	RO-8A4C3- SO-0002			
-					60/48		
5							
-		Silty Clay-dark brown, non-plastic, stiff, britt	tle damo shell	RO-8A4C3- SO-0507			
-	CL	fragments.	au, camp, anon	,	60/48		
				RO-8A4C3- SO-1012			
				RO-8A4C3-	60/60		
-15	SM	Silty Sand-brown, soft, fine to medium grai	ins, little clay.	SO-1314			
SITE MANAGER	: M. MEENAN				$\top$		unn avnaw
CHECKED BY:			TETRA TECH	NUS INC			IDE OXBOW ORTH, TEXAS
DRAWN BY: J.		<b>  Tt</b>	Houston, Texas			I OKI W	oning tunno
DATE: 05-20-	-02	SCALE: N/A	-		1	SOIL B	IORING LOG



				BOREHOLE		: 8A40	C-3	Page 3 of 4	
				LATITUDE: 32° 45' LONGITUDE: 97° 1		El	LEVATION/DAT	'UM: 502.450' M.S.L.	
t		PROJEC	T INFORMATION		DRILLI	ING INF	ORMATION		
	PROJECT: F JOB NUMBE LOGGED BY PROJECT M DATE DRILL	Riverside Ox ER: N7551.0 7: K. Bell MANAGER: I	bow 42D M. Meenan	DRILLING COMP DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET TOTAL DEPTH: 0	PANY: Groundw lerson 75 ILLING: Hollow HOD: 5' x 2" Sp	vater Mon	nitoring Inc.	9	
I	NOTES:			30.00' ☑	30.00' ☑ Initial Water Level 05-07-02				
١				22.16' ▼	Static Water	Level (	05-10-02		
	DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCR	IPTION	SAMPLE R	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
	-30	SM	Silty Sand-brown, fine grains, shell fragm some silty layers.	ents, saturated, loose,	RO-8A4C3- SO-3032	60/42			
	- - 35	- 35				60/42	-		
	-				RO-8A4C3- SO-3539	60/24			
	-40								
	-				RO-8A4C3- SO-4143	60/48			
	-45	SP	Sand-grey and variable, some gravel, lif medium to coarse subrounded gr some gravel.	tle silt and clay in areas, ains, loose, wood debris,					
	SITE MANAGER:	M. MEENAN				T			
1	CHECKED BY: K			TETRA TECH	NIIS INC			DE OXBOW	
3	DRAWN BY: J. I		<b>]                            </b>	Houston, Texas	NOS, INC.	1	FORT W	ORTH, TEXAS	
	DATE: 05-20-0	)2	SCALE: N/A	)		1	SOIL B	ORING LOG	

**BOREHOLE NUMBER: 8A4C-3** Page 4 of 4 LATITUDE: 32° 45' 4.501" N ELEVATION/DATUM: 502.450' M.S.L. LONGITUDE: 97° 18' 2.502" W DRILLING INFORMATION PROJECT INFORMATION DRILLING COMPANY: Groundwater Monitoring Inc. PROJECT: Riverside Oxbow DRILLER: R. Anderson JOB NUMBER: N7551.042D RIG TYPE: CME-75 LOGGED BY: K. Bell METHOD OF DRILLING: Hollow Stem Auger/Rock Coring PROJECT MANAGER: M. Meenan DATE DRILLED: 05-07-02 SAMPLING METHOD: 5' x 2" Split Spoon TOTAL DEPTH: 60' NOTES: 30.00' ℧ Initial Water Level 05-07-02 Static Water Level 05-10-02 22.16' 💌 ADVANCE WELL DESCRIPTION SAMPLE **BORING** DEPTH SOIL USCS: SOIL DESCRIPTION RECOVER NUMBER COMPLETION SYMBOLS (Inches 60/0 Sand-grey and variable, some gravel, little silt and clay in areas, medium to coarse subrounded grains, loose, wood debris, -50 SP some gravel. 60/0 -55 Gravel-coarse, subrounded, variable color, no matrix support, GΡ RO-8A4C3-SO-5558 very loose. 60/36 GP Limestone or loose, large gravel. RO-8A4C3-SO-5860 GM Clayey, Silty Gravel-grey, saturated, very loose. Bottom of hole - Total Depth=60'. SITE WANAGER: M. MEENAN RIVERSIDE OXBOW CHECKED BY: K. BELL TETRA TECH NUS, INC. FORT WORTH, TEXAS DRAWN BY: J. FLESCH Houston, Texas SCALE: N/A DATE: 05-20-02 SOIL BORING LOG CAD DWG. NO.: 8A4C-3 PROJ. NO.: N7551.042D

Γ				BOREHOLE	NUMBER	2 · 8Δ4	C-4	Page 1 of 3
				LATITUDE: 32° 45'		·. 0/	<b>-</b>	1 age 1 of 3
1				LONGITUDE: 97° 1		Е	LEVATION/DAT	UM: 505.743' M.S.L.
t		PROJEC	T INFORMATION		DRILL	ING INF	FORMATION	
	PROJECT: F JOB NUMBE LOGGED BY PROJECT M DATE DRILL NOTES:	ER: N7551.0 Y: K. Bell IANAGER: I	42D M. Meenan	DRILLING COMP DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET TOTAL DEPTH:	lerson 75 ILLING: Hollo HOD: 5' x 2" \$	w Stem A	uger/Rock Coring	3 Tube/10' x 2" Core Barrel
				0.94' ▼				
	DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
	_ ▼	CL SC	Surface-grass, damp, topsoil. Topsoil-silty clay, brown, roots, some gravel, Gravelly, Clayey Sand-light brown (reddish t dense, damp.  Silty Clay-dark brown, stiff, slightly plastic, di	prown), medium	RO-8A4C4- SO-0102			
	-	CL	above filled in cracks in clay (fractures in core (not due to drilling).	s), vertical migration		60/60		
	5	ML	Clayey Silt-brown, some gravel, non-plastic,	, damp.	RO-8A4C4- SO-0507	60/60		
	10							
	-				RO-8A4C4- SO-1012			
		CL	Silty Clay-light brown and tan, iron staining, limestone/shale, stiff, moist at 17'.	, badly weathered,		60/60		
ラ	SITE MANAGER:  CHECKED BY: K  DRAWN BY: J. F  DATE: 05-20-0	C. BELL. FLESCH	SCALE: N/A	TETRA TECH Houston, Texas	NUS, INC.		FORT WO	DE OXBOW DRTH, TEXAS ORING LOG

			BOREHOLE		R: 8A4	C-4	Page 2 of 3	
			LATITUDE: 32° 45' LONGITUDE: 97° 1		E	LEVATION/DAT	'UM: 505.743' M.S.L.	
	DPO IEC	T INFORMATION				FORMATION		
JOB NUMB LOGGED B PROJECT I	Riverside Ox ER: N7551.0	bow 42D M. Meenan	DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube/10' x 2" Core E TOTAL DEPTH: 35'				
NOTES:			0.94' ▼					
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
15				RO-8A4C4- SO-1517	60/60			
20	CL	Clay-weathered shale/limestone interbedde soft, mostly soft, thin layers of rock.	d, medium stiff to	RO-8A4C4- SO-1920				
				RO-8A4C4- SO-2224 RO-8A4C4- RK-2425	60/42			
25 - - -	SHALE	Limestone and Shale-fossils, grey, fine bed horizontal fractures.	ding features,		60/60			
-30				RO-8A4C4- RK-2535				
SITE MANAGER:			TETDA TECU	NILIS INC			DE OXBOW	
DRAWN BY: J.			TETRA TECH Houston, Texas			FORT WO	ORTH, TEXAS	
DATE: 05-20-	-02	SCALE: N/A			1	SOIL B	ORING LOG	

				BOREHOLE	NUMBE	R: 8A4		Page 3 of 3
			1	LATITUDE: 32° 45'	22.992" N			
			I	LONGITUDE: 97° 1	7' 18.956" W		ELEVATION/DA	TUM: 505.743' M.S.L.
	PROJEC	CT INFORMATION	١		DRIL	LING IN	FORMATION	l
JOB NUMB LOGGED B PROJECT I DATE DRIL	IOB NUMBER: N7551.042D LOGGED BY: K. Bell				ANY: Ground erson 75 ILLING: Holld HOD: 5' x 2"	w Stem A	luger/Rock Corin	ig Tube/10' x 2" Core Barrel
				0.94' ▼	Static Wat	er Level	05-10-02	
DEPTH (Feet)	SOIL SYMBOLS	uscs	: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
-30 - - - -35 - - -40 - - -45	SHALE	Limestone and Shale-fo  Bottom of hole.  Total Depth=35*	essils, grey.			60/60		
SITE MANAGER CHECKED BY:				TETRA TECH	NILIS INIC	Т		SIDE OXBOW
DRAWN BY: J.				Houston, Texas			FURI W	ORTH, TEXAS
DATE: 05-20-	-02	SCALE: N/A				1	SOIL	BORING LOG

			BOREHOLE	NUMBER	: 8A40	C-5	Page 1 of 4
			LATITUDE: 32° 45'	20.135" N			
			LONGITUDE: 97° 1	17' 18.339" W	El	_EVATION/DAT	'UM: 512.031' M.S.L.
	PROJEC	T INFORMATION		DRILLI	ING INF	ORMATION	
LOGGED B	ER: N7551.0	42D M. Meenan	DRILLING COMP DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET TOTAL DEPTH:	lerson -75 :ILLING: Hollow 'HOD: 5' x 2" Sp	Stem Au	ger/Rock Corin	9
NOTES:			30.00' ☑ 16.60' 坙	Initial Water Static Water			
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIPT	TION	SAMPLE R	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
Г0		Surface-fill material, bricks, gravel, topsoil.		T			
		Guitaco III II I		RO-8A4C5- SO-0002			
- - 5	FILL	Fill Material-brown, sand, gravel, clay, silt, b	oricks, crushed		60/42		
-		concrete, wood, wires, other debris.		RO-8A4C5- SO-0507	60/24		
10						,	
		·		RO-8A4C5- SO-1012			
					60/24		
-15	SM	Silty Sand-brown, damp, loose, some wood	d, gravel, coarse sand.				
SITE MANAGER:	M. MEENAN				Т		DE OVDOW
CHECKED BY:			TETRA TECH	NUS INC			DE OXBOW ORTH, TEXAS
DRAWN BY: J.		SCALE: N/A	Houston, Texas				
DATE: 05-20-	·UZ	SUALE: N/A			1	SOIL B	ORING LOG

**BOREHOLE NUMBER: 8A4C-5** Page 2 of 4 LATITUDE: 32° 45' 20.135" N LONGITUDE: 97° 17' 18.339" W ELEVATION/DATUM: 512.031' M.S.L. PROJECT INFORMATION DRILLING INFORMATION DRILLING COMPANY: Groundwater Monitoring Inc. PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D DRILLER: R. Anderson RIG TYPE: CME-75 LOGGED BY: K. Bell METHOD OF DRILLING: Hollow Stem Auger/Rock Coring PROJECT MANAGER: M. Meenan SAMPLING METHOD: 5' x 2" Split Spoon **DATE DRILLED: 05-07-02** TOTAL DEPTH: 60' NOTES: 30.00' ℧ Initial Water Level 05-07-02 16.60' ▼ Static Water Level 05-10-02 ADVANCE/ RECOVER WELL DESCRIPTION SAMPLE NUMBER BORING DEPTH (Feet) SOIL USCS: SOIL DESCRIPTION SYMBOLS COMPLETION (Inches) RO-8A4C5-SO-1517 60/36 - -20 RO-8A4C5-SO-2022 SM Silty Sand-dark brown, increased organic content, damp, loose. 60/36 -25 RO-8A4C5-SO-2527 60/54 <sub>-30</sub> 又 SITE MANAGER: M. MEENAN RIVERSIDE OXBOW CHECKED BY: K. BELL TETRA TECH NUS, INC. FORT WORTH, TEXAS DRAWN BY: J. FLESCH Houston, Texas DATE: 05-20-02 SCALE: N/A SOIL BORING LOG CAD DWG. NO.: 8A4C-5 PROJ. NO.: N7551.042D

				BOREHOLE	NUMBER	R: 8A4	C-5	Page 3 of 4		
			1	LATITUDE: 32° 45'	20.135" N					
1				LONGITUDE: 97° 1	ONGITUDE: 97° 17' 18.339" W ELEVATION/DATUM: 512.031' M.S.					
		PROJEC	T INFORMATION	DRILLING INFORMATION						
	PROJECT: I JOB NUMBE LOGGED B PROJECT IN DATE DRILL	ER: N7551.0 Y: K. Bell MANAGER: I	42D M. Meenan	DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon TOTAL DEPTH: 60'					
	NOTES:			30.00' ☑	30.00'   ✓ Initial Water Level 05-07-02					
				16.60' ▼	Static Water	er Level	05-10-02			
	DEPTH (Feet)				SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION		
	-30	ML	Clayey Silt-dark brown, medium stiff, damp to at 27°, saturated at 30°, clay content in	o moist, soft and wet creases with depth.	RO-8A4C5- SO-3032					
	-		,			60/36				
)	-									
	-35				RO-8A4C5- SO-3537					
						60/36				
		ML	Clayey Silt-brown, saturated, soft, slightly pl	lastic, iron staining.						
	-40				RO-8A4C5- SO-4042		·			
	-	CL	Silty Clay-brown, iron staining, medium stiff	f, plastic, wet.		60/36				
	L-45									
3	SITE MANAGER:							DE OXBOW		
Ĵ	DRAWN BY: J.		<b>T</b>	TETRA TECH Houston, Texas			FORT WO	ORTH, TEXAS		
	DATE: 05-20-	02	SCALE: N/A	nousion, lexas	SOIL BORING LOG					

				BOREHOLE		R: 8A4	C-5	Page 4 of 4	
				LATITUDE: 32° 45'			I EVATION/DAT	TUM: 612 031' M S I	
		T 11   50   51   11   11   11   11   11		LONGITUDE: 97° 17' 18.339" W ELEVATION/DATUM: 512.031' M.S.L.  DRILLING INFORMATION					
JOB NU LOGGE PROJEC	PROJECT: Riverside Ox MBER: N7551.0 D BY: K. Bell CT MANAGER: RILLED: 05-07-	M. Meenan	DRILLING INFORMATION  DRILLING COMPANY: Groundwater Monitoring Inc.  DRILLER: R. Anderson  RIG TYPE: CME-75  METHOD OF DRILLING: Hollow Stem Auger/Rock Coring  SAMPLING METHOD: 5' x 2" Split Spoon  TOTAL DEPTH: 60'						
NOTES:			30.00' ☑	Initial Wate	er Level	05-07-02			
			16.60' ▼	Static Wat	er Level	05-10-02			
DEPTH SOIL USCS: SOIL DESCRIPTION				TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
-45	-45 CL Silty Clay-grey, stiff, plastic, wet.				RO-8A4C5- SO-4547				
50	ML	Clayey Silt-grey, satura silty clay at 56', v		soft at 52', grades to	RO-8A4C5- SO-5052	60/36			
	GP Silty Gravel-grey, saturated, coarse sand, i		arge gravel (palm	RO-8A4C5- SO-5557	60/24				
-60	Limestone-yellow/tan/grey, hard, brittle, frac thick, breaks easily with pressure.  Bottom of hole - Total Depth=60'.			ctures horizontally 1/2"	RO-8A4C5- SO-5860				
	GER: M. MEENAN					_			
	BY: K. BELL			TETRA TECH	NI IS INC			IDE OXBOW	
	. J. FLESCH		Tt	Houston, Texas	NUS, INC.		FURI W	ORTH, TEXAS	
DATE: 05-20-02 SCALE: N/A					- 1	SOIL BORING LOG			

				BOREHOLE	NUMBEE	D . Q A A	C-6	Page 1 of 4	
						C. 6A4	C-0	Page 1 014	
\			ι	LATITUDE: 32° 45'	11.518" N				
)			·	LONGITUDE: 97° 1				TUM: 526.945' M.S.L.	
	PROJEC	TINFORMATION			DRILL	ING IN	FORMATION		
PROJECT: F JOB NUMBE LOGGED B' PROJECT N DATE DRILL	ER: N7551.0 Y: K. Bell MANAGER: I	42D M. Meenan	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 60'						
NOTES:				30.00' ☑ 25.17' ▼	Initial Wate Static Wate				
DEPTH (Feet)			TON	SAMPLE	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION		
_o		2 ( i i i i i i i i i i i i i i i i i i	at to sive						
-	Surface-topsoil, grass, levee adjacent to river FILL Silty Clay-brown, some sand, loose, damp, n FILL Clayey Gravel-concrete fill, crushed, brown.			RO-8A4C6- SO-0002					
-			l, brown.			60/36			
5	5  - CL Silty Clay-dark brown, non-plastic, brittle, ve			ry stiff, damp.	RO-8A4C6- SO-0507	60/48			
10					RO-8A4C6- SO-1012	60/48			
L <sub>-15</sub>									
SITE MANAGER:	N NEENIN								
CHECKED BY:						1		SIDE OXBOW	
DRAWN BY: J.				TETRA TECH			FORT W	ORTH, TEXAS	
DATE: 05-20-		SCALE: N/A		Houston, Texas		1	SOII I	BORING LOG	
CAD DWG, NO.: BA4C-6 PROJ. NO.: N7551.042D							SOIL BORING LOG		

	ı	BOREHOLE	NUMBER	R: 8A4	C-6	Page 2 of 4
	ι	LATITUDE: 32° 45'	11.518" N			
	LONGITUDE: 97° 17' 17.121" W ELEVATION/DATUM: 526.945' M.S.L.					
PROJEC	T INFORMATION		DRILL	ING IN	FORMATION	
PROJECT: Riverside Oxl JOB NUMBER: N7551.0 LOGGED BY: K. Bell PROJECT MANAGER: N DATE DRILLED: 05-07-0	42D M. Meenan	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 60'				
NOTES:		30.00' ☑ 25.17' ▼	Initial Wate Static Wate			
DEPTH SOIL SYMBOLS	USCS: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
15			RO-8A4C6- SO-1517	60/60		
	Silty Clay-brown, caliche, shell fragments, n plastic, damp, <1% sand, slightly plas wet at 28', very soft and saturated at 3	stic at 18', soft and	RO-8A4C6- SO-2022	60/60		
25 <b>▼</b>			RO-8A4C6- SO-2527 RO-8A4C6- ST-2527	60/60		
SITE MANAGER: M. MEENAN CHECKED BY: K. BELL		TETRA TECH	NIIS INC	T		SIDE OXBOW ORTH, TEXAS
DRAWN BY: J. FLESCH DATE: 05-20-02	SCALE: N/A	Houston, Texas				BORING LOG

			BOREHOLE	NUMBER	R: 8A4	C-6	Page 3 of 4	
			LATITUDE: 32° 45' 11.518" N					
			LONGITUDE: 97° 17' 17.121" W ELEVATION/DATUM: 526.945' M.S.L.					
	PROJEC	T INFORMATION	DRILLING INFORMATION					
PROJECT: F JOB NUMBE LOGGED BY PROJECT M DATE DRILL	ER: N7551.0 Y: K. Bell MANAGER: I	42D M. Meenan	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 60'					
NOTES:			30.00' ☑ 25.17' ▼	Initial Water Level 05-07-02 Static Water Level 05-10-02				
DEPTH (Feet)			TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
-30	-30			RO-8A4C6- SO-3032				
-				RO-8A4C6- ST-3032				
-	Silty Clay-brown, caliche, shell fragments, r plastic, damp, <1% sand, slightly plas wet at 28", very soft and saturated at 3				60/36			
35 -	35 -			RO-8A4C6- SO-3537				
-					60/48			
40 -	ML	Clayey Silt-dark brown, saturated, soft.		RO-8A4C6- SO-4042 RO-8A4C6- ST-4042				
-				DO 81400	60/60			
				RO-8A4C6- SO-4445				
SITE MANAGER:	M. MEENAN				$\top$	DIVERS	SIDE OVROW	
CHECKED BY: DRAWN BY: J.		<b>T</b>	TETRA TECH				SIDE OXBOW ORTH, TEXAS	
DATE: 05-20-	-02	SCALE: N/A PROL. NO.: N7551.0420	Houston, Texas	•		SOIL	BORING LOG	

				BOREHOLE	NUMBE	R: 8A4	.C-6	Page 4 of 4		
				LATITUDE: 32° 45'	11.518" N					
				LONGITUDE: 97° 17' 17.121" W ELEVATION/DATUM: 526.945' M.S.L.						
PROJECT INFORMATION			V	DRILLING INFORMATION						
PROJECT: Riverside Oxbow JOB NUMBER: N7551.042D LOGGED BY: K. Bell PROJECT MANAGER: M. Meenan DATE DRILLED: 05-07-02				DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 60'						
NOTES:				30.00' ∑ 25.17' <b>⊻</b>	Initial Wate					
DEPTH (Feet)	SOIL SYMBOLS	uscs	: SOIL DESCRIF	PTION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION		
<b>-45</b>										
- - - 50	ML	Clayey Silt-dark brown,	saturated, soft.			60/0				
-						60/0				
55 - -						60/24				
	GP		thered limestone for nale.	d, some coarse sand, 4" ollowed by 6" of grey	RO-8A4C6- SO-5860					
∟ <sub>-60</sub>										
SITE MANAGER:							RIVERS	SIDE OXBOW		
CHECKED BY:			[ <b></b>	TETRA TECH	NUS. INC			ORTH, TEXAS		
DRAWN BY: J. DATE: 05-20-		SCALE: N/A	It	Houston, Texas						
DATE: 05-20-02 SCALE: N/A  CAD DWG, NO.: 8A4C-6 PROJ. NO.: N7551.042D				,			SOIL BORING LOG			

			BOREHOLE	NUMBER	R: 8A4	C-7	Page 1 of 4		
			LATITUDE: 32° 45°	15.370" N					
			LONGITUDE: 97° 1	17' 12.508" W	E	LEVATION/DA	TUM: 506.082' M.S.L.		
	PROJEC	CT INFORMATION	DRILLING INFORMATION						
JOB NUMB LOGGED B PROJECT	Riverside O ER: N7551.0 Y: K. Bell MANAGER: LED: 05-08-	042D M. Meenan	DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 52'					
NOTES:			25.00' ☑	25.00' ☑ Initial Water Level 05-08-02					
			20.92' ▼	Static Water	er Level	05-10-02			
DEPTH (Feet)	SOIL SYMBOLS	USCS: SOIL DESCRIP	TION	NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION		
		Surface-wood debris, grass, topsoil, soft.	71.0						
-	FILL Fill-grey and brown, clay and silt, wood and c		organic debris, metal	RO-8A4C7- SO-0002					
-					60/36				
				RO-8A4C7- SO-0507					
10	CL	Silty Clay-grey, damp, medium stiff, slightly caliche in fractures, grades to brown non-plastic and brittle at 15'.			60/48		-		
				RO-8A4C7- SO-1012					
-					60/48				
L <sub>-15</sub>	L	L							
SITE MANAGER:						RIVERS	SIDE OXBOW		
CHECKED BY:			TETRA TECH	NUS, INC.		*****	ORTH, TEXAS		
DRAWN BY: J. DATE: 05-20-		SCALE: N/A	Houston, Texas						
					1	SOIL E	BORING LOG		

**BOREHOLE NUMBER: 8A4C-7** Page 2 of 4 LATITUDE: 32° 45' 15.370" N LONGITUDE: 97° 17' 12.508" W ELEVATION/DATUM: 506.082' M.S.L. DRILLING INFORMATION PROJECT INFORMATION PROJECT: Riverside Oxbow DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson JOB NUMBER: N7551.042D RIG TYPE: CME-75 LOGGED BY: K. Bell METHOD OF DRILLING: Hollow Stem Auger/Rock Coring PROJECT MANAGER: M. Meenan SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube **DATE DRILLED: 05-08-02** TOTAL DEPTH: 52' NOTES: 25.00' 🗸 Initial Water Level 05-08-02 20.92' ▼ Static Water Level 05-10-02 ADVANCE/ WELL DESCRIPTION SAMPLE NUMBER **BORING** DEPTH SOIL USCS: SOIL DESCRIPTION COMPLETION (Feet) SYMBOLS (Inches) RO-8A4C7-SO-1517 Silty Clay-grey, damp, medium stiff, slightly plastic, fossils, roots, caliche in fractures, grades to brown with depth, wet at 27', non-plastic and brittle at 15'. CL 60/60 -20 ¥ RO-8A4C7-SO-2022 60/60 --25 ▽ RO-8A4C7-SO-2527 60/60 SITE MANAGER: M. MEENAN RIVERSIDE OXBOW CHECKED BY: K. BELL TETRA TECH NUS, INC. FORT WORTH, TEXAS DRAWN BY: J. FLESCH Houston, Texas SCALE: N/A DATE: 05-20-02 SOIL BORING LOG CAD DWG. NO.: 8A4C-7 PROJ. NO.: N7551.042D

Г									
					BOREHOLE		K: 8A4	C-7	Page 3 of 4
1				LATITUDE: 32° 45' 15.370" N					
1	L			LONGITUDE: 97°	17' 12.508" W	E	LEVATION/DA	TUM: 506.082' M.S.L.	
	PROJECT INFORMATION				DRILI	ING IN	FORMATION	l	
Γ	PROJECT: Riverside Oxbow				DRILLING COM		water Mo	nitoring Inc.	
١	JOB NUMBER: N7551.042D				DRILLER: R. An RIG TYPE: CME				
-	PROJECT I	MANAGER:	M. Meenan				w Stem A	uger/Rock Corin	ng
١	DATE DRILLED: 05-08-02			METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube					
ļ				TOTAL DEPTH:	52'				
١	NOTES:				25.00' ☑	Initial Water	r Level	05-08-02	
١					20.92' ▼	Static Water	er Level	05-10-02	
	DEPTH (Feet)	SOIL SYMBOLS	uscs	: SOIL DESCRIPT	TION	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION
t	<b>-</b> -30		L						
١									
١	-								
١									
١	t								
١							60/0		
١	Γ								
-77	L							,	
1	-35								
		1				RO-8A4C7- ST-3536			
	<b> </b> -	1				0.000	1		
	-								
							60/36		
		l				1			
		ML	Clayey Silt-grey, soft,	aturated.					
	lΓ								
	-40								
			1						
	-					RO-8A4C7- ST-4042			
		1	į .						
	<b> </b> -						1		
		1					60/48		
	<b> </b>	1							
		1							
	1 [	1	1						
	L <sub>-45</sub>								
	SITE MANAGER	M. MEENAN					_		
6	CHECKED BY:				TETOA TEGU	NIIIO INIO			SIDE OXBOW
2	DRAWN BY: J.	FLESCH			TETRA TECH Houston, Texas			FORT W	ORTH, TEXAS
	DATE: 05-20-		SCALE: N/A		nousion, lexus	•		SOIL E	BORING LOG
	CAD DWG. NO.	. 0140-7	PROJ. NO.: N7551.042D				1		

	-			BOREHOLE	NUMBE	R: 8A4	.C-7	Page 4 of 4	
				LATITUDE: 32° 45'	15.370" N				
				LONGITUDE: 97° 1	7° 12.508" W	E	:LEVATION/DAT	TUM: 506.082' M.S.L.	
	PROJEC	T INFORMATION	٧	DRILLING INFORMATION					
JOB NUMB LOGGED B PROJECT I DATE DRIL	Riverside Ox SER: N7551.0 3Y: K. Bell MANAGER: M LLED: 05-08-0	M. Meenan	DRILLER: R. And RIG TYPE: CME- METHOD OF DR SAMPLING MET	DRILLING COMPANY: Groundwater Monitoring Inc. DRILLER: R. Anderson RIG TYPE: CME-75 METHOD OF DRILLING: Hollow Stem Auger/Rock Coring SAMPLING METHOD: 5' x 2" Split Spoon/2' x 2" Shelby Tube TOTAL DEPTH: 52'					
NOTES:				25.00' ☑	Initial Water	er Level	05-08-02		
-				20.92' ▼	Static Wat	er Level	05-10-02	1	
DEPTH (Feet)	SOIL SYMBOLS	USCS:	: SOIL DESCRIPT	ΠΟΝ	SAMPLE NUMBER	ADVANCE/ RECOVER (Inches)	BORING COMPLETION	WELL DESCRIPTION	
-45	-45				RO-8A4C7- ST-4547				
- - 	GM Clayey, Silty Gravel-grey, variable color, loc		ry, variable color, loo	ose, saturated.		60/24			
-		Bottom of hole.			RO-8A4C7- ST-5052				
		Total Depth=52'							
- 									
60									
SITE MANAGER:	: M. MEENAN					T			
CHECKED BY:				TETRA TECH	MILE INC	1		SIDE OXBOW	
DRAWN BY: J.				Houston, Texas		1	FURI #	ORTH, TEXAS	
DATE: 05-20-	DATE: 05-20-02   SCALE: N/A			incusion, ronds			SOIL BORING LOG		